Universities and Businesses: What Businesses Expect of Universities

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It is my great honor to be invited to this significant International Forum on Higher Education as a keynote speaker. In the time allotted me, I will share with you my opinions on the subject of "Universities and Businesses: What Businesses Expect of Universities."

My presentation will be in two parts. Part One deals with "Currents in Industrial Society," describing in what direction the world is headed and the kind of individuals who will be needed in the future.

In Part Two I would like to focus on "What the Industrial World Expects of the Universities" under those future circumstances.

First let me discuss Part One. Focusing on what we may call "informationized society," I would like to identify its several trends and then set forth what competent individuals are like therein.

Contemporary society is moving toward a high degree of informationization. What is required of human beings is not only a mere reading and writing capability but also an improved level of information literacy. Japanese society has passed from an agricultural to an industrial community and is now headed for an information-oriented one. In an agricultural community, the production of food was naturally a primary activity while in an industrial community the creation of energy played a very important role. In contrast, the informationized society, which is currently in the process of formation, features an extremely great importance attached to information. According to Alvin Tofler, the so-called information revolution occurred in the United States in the 1955-65 period. In my analysis, Japan has become a completely matured industrial society which is on the threshold of becoming a full-fledged informationized society.

In this context, information literacy refers to the human capacity to

absorb, express, create and process information. Assuming that the informational society is at an age where such a capacity is in great demand, the first trend is to train people to respond to that need.

The second trend is towards high technology, where the capacity for creativity and originality is essential. In a 1987 study entitled "White Paper on Science and Technology," projections were made on what Japan's technological development potential will be in 2000. In terms of the capacity of technological development, the "White Paper" presented statistics using as parameters the capacity for independent development, the volume of funds and committed resources, and the achievements in research and development. The data estimated that with the United States put at 100, the predicted value for Japan in 2000 is approximately 70. However, Japan has recently bridged the gap with the United States in technological development capacity at a rate higher than expected.

In 1963 I went to the United States as a research visiting the Bell Laboratory, which deserves to be called the Mecca of telecommunications research. I carried with me a paper on research into PCM -- the present digital communication. The difference in research levels between the two countries at that time was illustrated by the fact that NEC was engaged in research into PCM at levels of 10 megabits per second, while the Bell Laboratory was developing PCM of 216 megabits per second. At NEC I had five or six young engineers working under me as research fellows, while Bell Laboratory had more than 50 researchers working under Dr. John Mayo (then head of the high-speed PCM division). By 1982, when I wrote about these experiences in an essay entitled "Eighteen Years, Past and Future," this difference was virtually gone. In that eighteen-year period Japan had made a successful all-out effort to catch up with the United States.

The type of education we conducted in those days was intended to prevent people from becoming dropouts. In that effort, I think we were right. It was no mistake at all for everyone concerned to join forces to prevent anyone from dropping out of school so that we could overtake the United States. However, we will be called upon to show originality in our education system in the eighteen years between 1983 and 2000. I want to stress that this period of time will require a qualitative shift in human resources and the appropriate training of researchers in tune with this new emphasis on originality. The very few

number of Japanese scientists who were awarded Nobel prizes from 1945 to 1988 illustrates the importance of this problem.

Therefore, the overriding task confronting the universities and the industrial world alike is how to equip graduates and workers with creative initiative. What I have always stressed is to "Let us approach creative initiative as a science!" In short, creativity in itself ought to be regarded as a subject of science. Creative resourcefulness has a variety of fields. Physics, mathematics, chess, *shogi* (Japanese chess), and art each have creative ingenuity. Although I admit I am a poor player of *go*, I have a strong interest in the game. The super-elites in the *go* world -- Otake, Rin Kaiho, Kato and Takenomiya -- have been playing *go* since they were about five or six years old. In the *shogi* world, master Tanigawa was my junior at middle school. When asked at what age he began to play *shogi*, he gave the expected answer of five or six years old. In *go* or *shogi*, the gifted persons are to be found at the age of five or six. To produce the super-elites, there ought to therefore be what is called a "veteran expert" who is provided rigorous training at the earliest age. This applies also to the field of physics. How old was Einstein when he distinguished himself? It is generally said that he was in the second or third year of middle school. In all likelihood, creative ingenuity will bud in infancy.

If this is the case, data ought to be collected on those who have received the Nobel prizes in physics, chemistry and mathematics and analyze the age factor to determine how to identify those youth endowed with creative originality. When I was attending college, I had the opportunity to live in the same rooming house as a fellow student who later distinguished himself as one of Japan's leading physicists, Dr. Kazuhiko Nishijima. He is the scientist who conceptualized the Nishijima-German theory, served as Dean of Science at the University of Tokyo and is currently engaged in the study of elementary particles. While studying with him, I realized that I had no bent for physics -- a discovery that proved to be a boon for me. However, I could clearly see Dr. Nishijima's instinctive capacity for physics. Why not scientifically gather such data on leading scientists such as Dr. Nishijima or Dr. Fukui and Dr. Hironaka, determining the stages of their intellectual originality, when their resourcefulness first was evident and how to accurately identify creative

initiative?

In addition to understanding the gift of creativity, we need to better grasp the concept of individuality. While in the past it could be said that the world was in a "period of the masses," the future, emerging world is definitely an age of *individualized* masses. In this age of individualized masses, what will be required is the elevation of individual personality. The age of the masses was a world of non-individuality. This new age, passing through what Hakuhodo calls "the period of mass divisions," is giving way to the age of "individual crowds." People, each with different values and needs, are gathering together. The world ought to satisfy their differing needs so that the day will certainly come when those needs will be fulfilled. As I envision it, this will be the great accomplishment of the 21st century.

The type of persons needed for this century will be what I have frequently referred to as "a V-shaped human being." By this I mean that an individual must be distinguished in one area above all others. Suppose you dig a hole. The deeper the hole you dig, the wider its mouth will naturally become until if you are not careful, it will collapse in on itself. Someone who engages in one area alone without destroying its "mouth" we call a vertical-type person. Such a person is necessary in a certain special areas, but the individuals who will be needed by future society are of the "V-shaped type." There are also some individuals who want to acquire versatile but superficial knowledge -- these I term "horizontal-type persons." Since the rising generation will seek to enlarge both their vertical and horizontal capabilities, the universities must accordingly offer such educational approaches.

Another force shaping future society is the trend towards a borderless world. Intermural cooperation, inter-industry business operations, and internationalization have a compound effect that oversteps traditional regional, cultural or national boundaries. It is not only important to improve these compound powers in the form of greater inter-business and interdisciplinary cooperation but also to promote internationalization.

It may also be necessary to reappraise the past classification of learning as the natural sciences, social sciences and humanities. The areas where those categories overlap are very important and in the future will assume even greater prominence. These three fields of natural science, social science and

human science deserve to be called collectively the information sciences.

As societies and fields of learning are becoming borderless, so too are businesses. The earliest businesses were characterized by one type of industry in a certain country. However, the walls of this industrial type are now gradually collapsing. Nippon Steel, for example, has today become a major industry that does not only produce iron and steel. The 1987 revision of its Articles of Association states that, "Nippon Steel will engage in information telecommunication operations, resort business, biotechnology . . ." Its long-term plan expects iron and steel production in 1995 to account for about one half of its estimated four trillion yen sales, or two trillion yen. The other half of its generated revenue will be attributed to chemical plants, biotechnological projects and information telecommunication business. A company which at one time specialized in iron and steel is transforming itself into a multi-industry corporation. Needless to say, large companies are becoming very active and diversified, crossing national borders.

The emergence of a borderless society is also seen in the nature of Japan's exchange of foreign students. According to data collected by the Ministry of Justice, about 10,000 Japanese students left this country for studies abroad in 1975, while about 5,000 foreign students came to Japan. In 1988, the number of Japanese students studying abroad dramatically rose to about 85,000 while the size of the foreign student population in the country also jumped to about 37,000. These figures are enough to convince us that there has been much progress in internationalization. And this trend will continue unabated, raising a question about the nature of cosmopolitan individuals in the borderless economy.

As internationalization takes place, it will be of primary importance that individuals have a sufficient understanding of their own culture while having a deeper appreciation of foreign cultures. Our native culture and a foreign culture will never be identical -- conflicts between cultures will invariably take place. Individuals who will be capable of sublimating (*aufheben*) these differences and conflicts will deserve to be called cosmopolitan. I believe that an education that builds this sense of cosmopolitanism is very necessary.

At this point I would like to move on to Part Two of my presentation --

industry-university cooperation and then the proper nature of university education as a whole. In a recent report by the Ministry of Education, "Results of the Joint Research System between the Universities and the Private Sector," statistics are given for the period 1983-88 that show changes in the number of industry-university joint research projects and the number of researchers accepted for such endeavors. Recently there has been a notable rise in the number of joint research projects, which implies that the universities and the private organizations have taken advantage of the joint research system to achieve their desired results.

One of the slogans of the student movement in the 1970s, marked by university disputes, was that industry-university joint research and commissioned studies were evil-natured. At that time, I did everything I could to deal with the situation. The Ministry of Education statistics reveals that industry-university joint research or commissioned research projects have directly increased as the student movement subsided.

To understand the reason for this upward trend, one must first acknowledge the growing importance of the development of first-line and original technologies. This has been the case particularly in the area of basic technology. To give the "big picture," the *Nikkei Sangyo Shimbun* of February 21, 1989 reported that the United States is logically number one in basic technology as well as in fields of new materials, electronics and biotechnology. Japan ranks second in certain areas as does Europe in others. Consequently, it is getting more and more important to develop leading-edge and unique basic technologies in Japan, and accordingly there is the need to push ahead with industry-university joint research programs.

Another reason for an increase in industry-university joint efforts is the narrowing of the time lag between basic technology development and its practical application. A review of data compiled by the United States Technical Assessment Agency would be helpful. In the technological field of photography, for example, it took more than than a century after its invention for photography to be put into practical use. The steam locomotive and telephone each took no less than seventy-five years following the first discovery of their principles to finally have practical application. However, in the case of recent inventions such as the transistor, the solar cell, and microelectronics, the

transition from invention to application required a much shorter period of time. The reduction of this time difference has pointed out the need for a unity between university basic research of a purely scientific nature and industrial research focussing on application.

A third factor in stimulating the union of industry and university is the speed with which knowledge can become out-of-date. Scientific and technological knowledge is making too rapid strides. The impact of this rapidity on the "human factor" is illustrated in a NEC survey conducted among its personnel. Assessing how NEC employees felt about gaps in their knowledge and capabilities, the survey showed that fifty of the one hundred persons who joined NEC between 1960-65 took more than ten years to feel a discrepancy between what they learned at college and the knowledge required on the job. There was a steady increase in the number of those who noticed such a gap in the time after they joined the company with about half sensing the difference in over ten years. The data of 1975-77 shows, however, that half of the one hundred employees surveyed found the technologies they had studied at college obsolete in one or two years after employment. These workers felt a keen need to study once again.

The NEC case reveals that after training at college and joining an organization, employees must continue their study because the advance of technology is so rapid. The technologies required of businesses are continually expanding, spiraling to ever higher levels. Accordingly, the universities and the industrial world ought to have closer ties and the former's knowledge and the latter's needs ought to be reconciled in the form of joint research. There are many forms of industry-university cooperation -- in recent years it is more and more common to see joint research projects or donated classes. In some cases a consortium has been formed comprised of more than one corporation and university. There has also been an interchange of personnel through academic or industrial associations or joint industry-university-government participation in a national project.

The problems with industry-university cooperation as seen from the viewpoint of business have been researched by the Society for Engineering Education Research. Acquiring data through a questionnaire survey, their results indicate that business are concerned about industry-university

cooperation in a variety of areas including the insufficiency of the planning or management structure, the difficulty of mapping out a long-range plan, the shortage of research facilities and equipment for the latest and most sophisticated research, the issue of preserving successful, important research results as classified data, or the questionable levels of research performed. Despite these concerns and recognizing the fallibility of human beings, an effort to make improvements in the industry-university relationship makes good sense. Industry and university should strive to push ahead with their joint research undertakings while simultaneously ameliorating their problems.

Consequently, there is a great necessity to raise the level of industry and university research through concerted action. Industry has already called for more energy to be devoted to basic research. According to the Statistical Bureau of the Management and Coordination Agency, in 1965 about 11.2% of the research spending of all the Japanese companies combined went to basic research, 31.3% to applied research, and 57.5% to developmental research. However, in 1980 a dramatic drop in basic research had taken place with only 5.0% of the research budget allocated to these efforts, while applied research received 19.5% and developmental research 75.5%. The absolute value of outlays for basic research may not have fallen, but its percentage share of total research sharply fell while a great deal of money was earmarked for developmental research projects. By 1986, the percentage of basic research picked up slightly, edging up to 6.1%.

To help remedy this situation, the level of resources diverted to basic research by industry should be increased. In fact, there is a need to raise the level of research spending in general. According to data contained in the 1989 "White Paper on Science and Technology," per-researcher research spending for 1986 was one million in Japan and one million in the United States. In the statistics for the United States, a certain amount of research expenditures for the human sciences may be included in the figure, but the natural sciences received the bulk of the money. The Japanese figures are virtually equal to the American levels as a whole. Focusing on research at the universities, per-researcher spending is one million in the United States and again, one million in Japan. While at this point Japan and the United States are comparable in the

level of money devoted to university research, university authorities or the Education Ministry had better raise a little more money to increase per-capita spending.

There ought to be better mutual understanding between university's "seeds"-oriented research projects and the industrial world's "needs"-oriented projects. I call out to both parties to strike a balance between "seeds" and "needs."

Another matter of equal importance is to find a proper solution to the question of the ownership of the results of a given research project. It is essentially an issue of intellectual property. On reflection, I realize that Japanese society has been in the past relatively open on this score. Of course, there are patents and copyrights, but it seems that Japan is more liberal in making judgments. The question of claiming and protecting such rights ought to be more properly handled in order to further industry-university cooperation.

I must also address the question of university education as a whole. The number of universities is progressively increasing with many more institutions of higher learning today than in the 1955-1964 and 1965-1974 periods. According to an announcement made by the Education Ministry, the number of university and postgraduate school graduates totaled about 410,000 in 1988 with the number of postgraduate school graduates being about 30,000. In 1965, the number of postgraduate school students stood at 7,000 and that of undergraduate students at 170,000. Such a sharp growth in the number of students in higher education is a very welcomed development. We would like to see the number of postgraduate students to continue to increase.

The role of the university is to engage in three jobs -- research, liberal arts education and professional education. Industry expects the university to effectively perform these functions. University professors are making efforts in many of these areas, but industry still has certain expectations of the kind of quality education to be offered to students. We expect the faculty to help students acquire a capacity to search for information, to conceive things in an original fashion, and to express themselves effectively instead of through rote learning. Students should be furnished not only with an analytical capability but also the creative power to pinpoint a problem, project it and solve it. In addition, image conception and awareness are of great value. The faculty are requested to develop the two sides of a student's brain, the left

portion affecting the powers of logic and intellect and the right portion affecting the powers of intuition and creativity. They are also invited to consider the deeper philosophical meaning of the nature of education. University education should be a transition from end-oriented (what and why) thinking towards means-oriented (how) thought.

In my opinion, education is supposed to give opportunities to as many people as possible, to discern their aptitude and rigorously train them according to their proven abilities. It is tragic when a gifted person, for economic reasons or otherwise, is not provided with an opportunity to develop themselves. Since Japan has become rich, and the number of those talented children who cannot afford to go to school has considerably been reduced, there are very few, if any, such children. While this is a very good trend, it is my desire that the rising generation should be granted even more opportunities in many areas and encouraged to give fuller play to their own distinctive personalities.

The university is "a place for intellectual excitement where a student should find his or her own aptitude and enhance his or her own creative resourcefulness through an exchange of lively human nature with full attention to the individual." What matters most in a university is individual education. It is an individual education that also helps a student become a person capable of teamwork. "An exchange of lively human nature," of course, refers to interchanges between students and faculty members, exchanges among friends, and interactions in academic settings.

The fulfillment of the human potential requires the effort to apply an education to a person's good qualities. No amount of effort will make a person into a first-class human being without those deep qualities. I am quite confident that the notion of educating everyone to the same level is unfounded. This is one of the lessons that I have learned from my own experience. You can set a standard at a certain level which everyone can reach through applied effort. Beyond that level, human happiness and fulfillment comes from discovering individual differences and special talents, and then being trained in that area.

My belief is that "spiritual affluence consists in having a worthwhile time." It is important therefore to find out as soon as possible what one's

"bent" is so that one can live a worthwhile life. An important, cooperative effort should be made by teachers, parents and even friends to help each student discover their individual gift, especially during the stage from the higher levels of senior high school through a university education. If a student has his or her gifts or aptitude thus identified and selects an appropriate future career, I believe that student will be able to choose the right path for deepening their knowledge and fulfilling their potential, whether in postgraduate studies or at a national or public research institute.

In other words, while they are still young, students should be offered by universities the necessary opportunities and skills to select the best and most appropriate life path. My friend and former college roommate, Dr. Nishijima, illustrates this point very dramatically. Although he has yet to receive a well-deserved Nobel prize, he is recognized as a man with tremendous and unique abilities. Yet, if he had entered the business world, I do not believe he would have attained such success. In the same light, if I had followed his path, I would never be what I am today.

The purpose of a university education is to help each student to realize his or her own talents, to identify an aptitude or bent and then provide rigorous, stimulating training in the activity for which they are best suited. Let me end my speech by placing this educational expectation squarely before the university.